NASA TECHNICAL TRANSLATION NASA TT F-16934

OUTSTANDING SUCCESS OF SOVIET COSMONAUTICS

V. Avduyevskiy, V. Ishevskiy, M. Marov
and V. Moroz

(NASA-TT-F-16934) OUTSTANDING SUCCESS OF SOVIET COSMONAUTICS (NASA) 10 p HC $3.50 CSCL 22C
N76-18194
Unclas
G3/13 20075

Translation of "Vydayushchiysya uspekh sovetskoy kosmonavtiki," Moscow, Pravda No. 52 (21021), February 21, 1976, pp 3-4

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546 MARCH 1976

STANDARD TITLE PAGE

1. Report No. NASA TT F-16934	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle OUTSTANDING SUCCESS OF SOVIET COSMONAUTICS		5. Report Date March 1976
		6. Performing Organization Code
7. Author(s) V. Avduyevskiy, V. Ishevskiy, M. Marov and V. Moroz		8. Performing Organization Report No.
		10. Work Unit No.
		11. Contract or Grant No. --
9. Performing Organization Name and Address National Aeronautics and Space Administration Washington, D. C. 20546		13. Type of Report and Period Covered Translation
12. Sponsoring Agency Name and Address National Aeronautics and Space Administration Washington, D. C. 20546		14. Sponsoring Agency Code
15. Supplementary Notes Translation of "Vydayushchiysya uspekh sovetskoy kosmonavtiki," Moscow, Pravda No. 52 (21021), February 21, 1976, pp 3-4		
16. Abstract		
17. Key Words (Selected by Author(s))	18. Distribution Statement Unclassified - Unlimited	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	10	

NASA-HQ

OUTSTANDING SUCCESS OF SOVIET COSMONAUTICS[1]
by

V. Avduyevskiy, V. Shevskiy, M. Marov and V. Moroz

On the threshold of the 25-th Congress of the CPSU*, domestic science and engineering have achieved new outstanding successes in the investigation of the planet Venus. On 22 and 25 October 1975 the descent vehicles of the "Venera-9" and "Venera -10" transmitted, for the first time in the history of cosmonautics, pictures of the planet surface to earth, and the probes themselves became its first artificial satellites.

The "Venera-9" and "Venera-10" were launched on 8 and 14 June 1975, respectively. Two days before flyby of the planet, the descent vehicles were separated from the probes and later performed the first soft landings on the lit side of Venus invisible from earth at this time. After separation the probes were injected into transfer orbits and then into orbits of artificial satellites of the planet with the parameters:

maximum distances from Venus surface (at apocenters) - 112,200 & 113,900 km;

minimum distances from surface (at pericenters) - 1,510 & 1,620 km;

inclinations of orbits to Venus equatorial plane - $34^{\circ}10'$ and $29^{\circ}30'$;

periods of rotation - 48 hours 18 minutes and 49 hours 23 minutes.

In order to transmit scientific information, an original ballistic scheme was developed which assures the requisite mutual spatial arrangement of the probes and the descent vehicles. All the information received by each descent vehicle was transmitted to "its" probe, starting a communication session with an artificial satellite of Venus, and was then relayed to earth.

The Soviet interplanetary probes to study Venus in 1967 and 1972 were produced by a gradual modification of the "basic" space vehicle "Venera-4". The formulation of new scientific problems, including taking pictures of the surface and considerable expansion of the composition of the scientific apparatus, did not permit utilization of the basic model. Hence, a new kind of probe was produced.

The "Venera-9" and "Venera-10", each of which includes the probe and the descent vehicle, are analogous in construction and equipment. The probes' weight (after injection into the transfer trajectory to Venus) was 4936 kg and 5033 kg, and the weight of each descent vehicle with its heat shield casing (after separation from the probe) was 1560 kg.

*CPSU = Communist Party of the Soviet Union

[1]Basic translation provided by Morris D. Friedman, Lockheed Missiles & Space Co.

DESCENT AND LANDING ON THE SURFACE

A study of the clouds located at an altitude of about 60 km, extensive investigations of the atmosphere, taking a picture of the surface after landing thereon, and conducting scientific experiments were in the research program of the "Venera-9" and "Venera-10" descent vehicles. This required the development of a new descent and landing scheme, which would assure a slow letdown in the cloud layer, rapid passage through the main thickness of the hot and dense atmosphere investigated earlier, and also a low landing velocity.

The descent vehicles entered the planet atmosphere at angles of 20.5° and 22.5° to the local horizon, respectively. After aerodynamic deceleration, the cover of the parachute compartments were jettisoned at about a 65 km altitude, and the pilot parachutes and the parachutes to remove the upper parts of the heat-shield casings were deployed simultaneously. The descent velocity was reduced from 250 to 150 m/sec. Then the drag parachutes were deployed, the radio complexes were switched on, and information transmission was started.

The drag parachutes having worked for 15 sec diminished the velocity of descent to 50 m/sec. The three-canopy main parachutes, 180 m^2 in total area, were deployed at altitudes on the order of 62 km. The lower hemispheres o the heat-shield casings were separated 4 seconds later.

The descent vehicles passed through the cloud layer in approximately 20 minutes, after which the parachutes were discarded. A further diminution in the letdown velocity was achieved because of the rigid aerodynamic decelerating units. After jettisoning of the parachutes, the letdown velocity of the descent vehicles hence first started to increase and diminished to approximately 7 m/sec near the surface because of the rise in density of the atmosphere. The landing units, which are thin-walled toroidal shells, were deformed during landing, thereby absorbing the energy of the impact, and assured an oriented position of the descent vehicles on the surface.

The covers protecting the telephotometer illuminators from contamination were discarded at the time of landing, and the booms of the radiation densitometers were released soon afterwards and extended on the surface.

Transmission of the television panorama by each descent vehicle started approximately 2 minutes after landing and lasted the whole time of their operation. Data from the scientific apparatus and service information about the state of the onboard instruments and their operating conditions was sent over these same radio links periodically. Information was transmitted for

53 minutes from the "Venera-9" and for 65 minutes from the "Venera-10" descent vehicle.

RESULTS OBTAINED

The information obtained by the Soviet "Venera" probes in 1967-1972 were the basis for composing the significantly more complete research program on the "Venera-9" and "Venera-10". A single complex of instruments was produced for the purpose of a thorough study of the Venus atmosphere, its cloud layer, the surface of the planet and the near-planet space. The composition of the apparatus on both probes is identical.

DESCENT VEHICLES

The following scientific apparatus was mounted on the descent vehicles:

A panoramic telephotometer to study the optical properties and to obtain images of the surface at the landing site;

A photometer to measure the light fluxes in the green, yellow, and red rays and in two sections of the near-infrared spectrum range (a band up to 1 μ);

A photometer to measure brightness of the atmosphere in three wavelength bands around 0.8 μ, and also to obtain data about the chemical composition of the atmosphere by an optical spectrum analysis method;

A complex to study the optical characteristics of the atmosphere and clouds by measuring the radiation intensity of an artificial light source, scattered by aerosol particles, which includes two instruments. One operated at 63 - 34 km altitudes, and the other at 63 - 18 km;

Pressure and temperature sensors operating from the 63 km altitude down to the surface;

Accelerometers to measure the g-forces originating during the aerodynamic deceleration phase when the vehicle entered the atmosphere;

A mass-spectrometer to measure the chemical composition of the atmosphere, which made measurements on the 63 - 34 km altitude phase;

An anemometer to determine the wind velocity on the planet surface;

A gamma spectrometer to determine the content of natural radioactive elements in the Venusian rocks. The instrument recorded the intensity and spectral composition of gamma radiation;

A radiation densitometer to determine the density of the soil in the surface layer of the planet. The operating principle of the instrument is based on a dependence existing between the density of the rock and the intensity of the gamma radiation it scatters, which has been produced by a source mounted on the densitometer.

A large volume of information, which is presently being processed, was obtained as a result of measurements from the descent vehicles. A number of preliminary deductions can be made on the basis of an analysis of the material.

Measurements of the atmosphere pressure and temperature confirmed the dependence of these characteristics on the altitude, which had been established during the preceding flights, and the model of the Venus atmosphere constructed on their basis. The temperature and pressure on the surface were $460^{\circ}C$ and 90 atm at the landing sites.

A considerable volume of mass-spectrometer information permits expansion of the representation of the chemical composition of the atmosphere and the cloud layer.

Data about the brightness in the carbon dioxide and water vapor bands show that water vapor in the 35 - 40 km altitudes is approximately one one-thousandth of the carbon dioxide.

A large volume of material has been obtained about the optical properties of the atmosphere and its cloud layer. They permit a judgment about such imp .nt characteristics of the atmosphere as the position, structure, and ir .nsity of the cloud cover, the concentration and mean size of aerosol particles in and below the clouds, the magnitude of solar radiation absorption at different altitudes in the atmosphere and on the Venus surface. Additional information about the cloud composition is yielded by the change in the spectrum composition of light as it passes through the cloud. The results of a preliminary analysis show that the aerosol is distributed nonuniformly in the atmosphere. Its main layer, representing the cloud particles, is above 49 km, the clouds themselves are sufficiently transparent and substantially less dense than on earth. Scattering particles of different chemical composition are apparently present in the atmosphere.

According to photometric measurement data, the illumination on the Venus surface turns out to be about 10000 lux, which corresponds, on earth, to illumination in the middle latitudes at midday when the sky is overcast.

According to the data on the Doppler frequency shift of the radio signal transmitted from the descent vehicle, the wind velocity at different altitudes was determined. Processing the results of these measurements showed that the structure of the atmospheric currents on the descent phases of both vehicles is quite similar and, on the whole, confirms the structure found by measurements of the "Venera-8" radio signals.

The local wind velocity on the surface was 0.4 - 0.7 m/sec according to preliminary data during the whole time of "Venera-9" operation, and 0.8 - 1.3 m/sec in the region of the "Venera-10" landing.

The content of natural radioactive elements in the Venusian rock was established on the basis of a gamma radiation analysis as: potassium 0.3 ; thorium 0.0002 , and uranium 0.0001 percent. This corresponds to the most widely ejected rock from the earth's crust, basalt, and indicates that rock enriched by natural radioactive elements is present on the Venus surface, as compared with their expected mean content on the planet. Such a crust could only be formed during separation of the Venus material on the shell during its evolution in the course of millions of years. The most volatile fraction of the melt, enriched by potassium, thorium, and uranium, from which the crust was evidently formed, hence emerged on the surface.

A comparison of the data about the moon, earth, Venus and Mars indicates that a sin e geochemical process proceeds in apparently all the planets of the earth group, separating them into shells, of which the upper, the crust consists primarily of basalt. Processing the results obtained by using the densitometer of the "Venera-10" descent vehicle showed that, with great confidence, the rock at the landing site has a 2.7 - 2.9 g/cm^3 density. This quantity agrees with the deduction about the basalt composition of the crust.

On the basis of measurements from the "Venera-8" it could be assumed that under almost midday illumination conditions it turns out to be possible to obtain a picture of the landing site without using artificial light sources. This assumption was justified. The panoramas transmitted are of special interest.

The landscape at the landing sites turned out to be different. A razval* of rocks predominantly several tens of centimeters in size is seen in the panorama transmitted from the "Venera-9" descent vehicle, while the panorama of the "Venera-10" descent vehicle landing area exhibits a smooth surface on which slightly elevated rocky clumps are seen. The depressions between them are covered by a layer of fine-grained soil. The region is probably in a compressed surface of the lowland or plateau type. Many rocks in a section of the "Venera-9" landing site have a sufficiently sharp outline. This indicates that the observed landscape is not very old in the geological time scale. The outcrops of excavated rocks at the "Venera-10" landing site have a spotty, pitted surface and smooth edges, which indicates processes of changes in indigenous mountain rocks and maturity of the landscape.

Compared to other planets, the Venus conditions are closest to the conditions of magmatic rock crystallization, which should contribute to

*razval = disintegrated blocks piled up on mountain slopes.

keeping them on the surface. At high temperatures the carbon dioxide atmosphere of the planet is not chemically active with respect to such rocks. Despite the high density of the atmosphere, the forces of impacts between particles is small because of the low wind velocity at the surface, which should not result in smoothing the relief because of erosion and the loss of fine dust in the atmosphere.

Further processing of the data promises new important information about the nature of Venus.

ARTIFICIAL SATELLITES OF VENUS

Artificial satellites of Venus permit conducting many investigations which are impossible to conduct from earth. Small mounted astronomical instruments yield much more detailed information about the planet (the resolution is tens of times better than the largest ground based telescopes). Multiple systematic investigations of the very same areas of the planet from different directions afford the possibility of surveying it as a whole, of representing the total picture of the cloud cover, and of studying its changes.

Investigations using artificial satellites of Venus are carried out in three main directions.

1. Study of the cloud layer with optical instruments. Used for this are:

A panoramic camera (yields pictures of the cloud layer);

An infrared spectrometer (measures the intensity of the absorption bands of the atmospheric gases and the reflexivity of the clouds in the 1.5 - 3 μ wavelength band);

An infrared radiometer (measures the temperature of the cloud cover in the 8 - 30 μ wavelength range);

A photometer (measures the brightness of the cloud cover at ultraviolet rays at the 3500 Å wavelength);

A photo-polarimeter (measures the brightness and polarization of the solar radiation reflected by the cloud cover in the 4000 - 7000 Å wavelength range);

A spectrometer (2400 - 7000 Å range) to investigate the structure of the layer above the clouds.

2. Study of the upper atmosphere by radiophysical and optical means. The radiophysical experiment is based on the translucence of the planet atmosphere by radiation of the probe radio transmitters prior to its setting behind the edge of the planet and after its rise. The altitude profile of the temperature and pressure (including even the relatively low layers of

the atmosphere) and the electron concentration in the ionosphere can be determined by means of the data from measuring this radiation.

The upper atmosphere is investigated by optical methods by two instruments: the photometer measures the solar radiation scattered by hydrogen atoms in the outer layers of the atmosphere, and the spectrometer measures the luminescence of the Venus atmosphere in the 3000 - 8000 Å range.

3. Study of the interaction between the solar wind, the flux of charged particles issuing from the sun, and the planet.

To do this, a magnetometer, a plasma electrostatic spectrometer, and charged particle traps are mounted on the satellites.

Details on the Venus disc, which are almost indistinguishable in the visible rays, are noticeable in the near ultraviolet band (about 3500-4000 Å wavelengths). Sufficiently stable dark spots, bands by which the velocity of cloud motions is determined, are observed here. Pictures of the cloud cover with such details are obtained in ultraviolet rays.

Measurements made simultaneously by the optical instruments during satellite passage through the pericenter have already yielded a large volume of information. Joint processing of the results of these measurements in combination with the data from the descent vehicles assists in refining the cloud layer composition and configuration.

A preliminary analysis of part of the information showed the following.

The cloud temperature at their upper boundary is about - 35°C with negligible fluctuations from section to section; the cloud temperature on the night side is approximately 10° higher than on the day side. The brightness in ultraviolet rays varies along the disc within 20% limits sometimes simultaneously with the changes in temperature.

Radioscopy afforded the possibility of a sufficiently detailed study of the vertical cross-section of the atmosphere in four regions above the day and night sides of the planet at 40 - 80 km altitudes. The complex configuration of the temperature profile was clarified. It diminishes with altitude, but local rises are observed at the 66 - 51 km level, which visibly indicates a multistage cloud cover configuration. It appeared to be similar on the day and night sides.

The Venus ionosphere is closer to the planet and thinner than on earth. The electron concentration on the day side is considerably greater than on the night side but is approximately one-tenth that on earth. Considerable variability is characteristic for the night ionosphere.

Repeated recording of the Venus night sky luminescence showed that its spectrum is similar to the luminescence spectrum of earth's night sky.

Processes occurring during interaction between the solar wind and Venus are studied from the satellites. Simultaneous data about the electron and ion concentration and temperature on both sides of the shock front near Venus have been obtained and the electron characteristics in the optical shade produced by the planet have also been measured.

The flight of the artificial satellites and the investigations of the planet continue. The new outstanding successes of Soviet science and engineering again confirms the enormous possibilities of automatic space vehicles for discovering the secrets of planets and the universe.